

## Making large free-standing multi-layer graphene/graphitic membranes

Kurganova, Evgenia; Giesbers, A.J.M.; Vollebregt, Sten; Notenboom, Arnoud; Vles, David; Nasalevich, Maxim; van Zwol, Peter

### Publication date

2018

### Document Version

Final published version

### Citation (APA)

Kurganova, E., Giesbers, A. J. M., Vollebregt, S., Notenboom, A., Vles, D., Nasalevich, M., & van Zwol, P. (2018). *Making large free-standing multi-layer graphene/graphitic membranes*. 1-1. Abstract from Graphene 2018, Dresden, Germany.

### Important note

To cite this publication, please use the final published version (if applicable).  
Please check the document version above.

### Copyright

Other than for strictly personal use, it is not permitted to download, forward or distribute the text or part of it, without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license such as Creative Commons.

### Takedown policy

Please contact us and provide details if you believe this document breaches copyrights.  
We will remove access to the work immediately and investigate your claim.

# Making large free-standing multi-layer graphene-graphitic membranes

---

**Evgenia Kurganova<sup>1</sup>**

A.J.M. Giesbers<sup>2</sup>, Sten Vollebregt<sup>3</sup>, Arnoud Notenboom<sup>1</sup>, David Vles<sup>1</sup>, Maxim Nasalevich<sup>1</sup>, Peter van Zwol<sup>1</sup>

<sup>1</sup> ASML, De Run 6501, Veldhoven, The Netherlands

<sup>2</sup> Philips Innovation Services, High Tech campus 4, Eindhoven, The Netherlands

<sup>3</sup> Delft University of Technology, Feldmannweg 17, Delft, The Netherlands

[Evgenia.kurganova@asml.com](mailto:Evgenia.kurganova@asml.com)

---

Graphene and very thin graphitic membranes have special properties. In the field of lithography, the high absolute transmission around 13.5 nm, the wavelength of choice of extreme ultraviolet (EUV) lithography, is an attractive property of thin carbon based membranes. Making large size ultrathin membranes is a challenge. As is well known, single layer graphene is a very strong material thanks to the honeycomb lattice and the pi-bonding between the carbon atoms. Therefore, graphene has been proposed being the ultimate material for large free standing membranes.

In reality, however, its high strength of ~100 GPa is limited to defect free monocrystalline material, which does not exceed areas of the order of a square mm. In practice, we therefore focus within ASML on finite thickness graphitic membranes with thicknesses of a few nanometers. In thin multilayer material, the membrane strength is found to be limited by local stress concentrations due to grain boundaries, considerable surface roughness, and also local holes.

We report on the status of our free standing thin graphitic membranes optimized in collaboration with our industrial and academic partners. Although being able to produce 12 nm thick freestanding membranes of 24x 24 mm<sup>2</sup> size, we found

that the mechanical strength did not exceed 360MPa, a strength that needs improvement. In small steps we have reduced the roughness and the number of holes in the graphitic membrane, making the membrane stronger.

In our poster/talk we will highlight our most interesting results and challenges.